Distribution in Time, Provenance, and Weathering of Gravestones in Three Northeastern Ohio Cemeteries[1]

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ABSTRACT. We examined every gravestone in three 19th-20th century Cleveland area cemeteries for date of death, rock type, style, and degree of weathering. We also examined grain size, mineral composition, and other features for every stone. The data allowed us to develop stone-use seriation patterns, determine stone provenance, and assess regional weathering patterns. Newspaper advertisements and other historical records were used to help interpret data. Local sandstones (Euclid bluestone and Berea Sandstone) were the first stones used for gravestones in the cemeteries. The use of sandstone for gravestones diminished during the 1830s. Sandstone continued to be used for monument bases, however, until the end of the 19th century. Imported marble was used for gravestones at least by the 1830s. Marble gravestones remained in use into the early 20th century. Use of granite appears to begin as early as marble in two of the cemeteries, but this probably represents the use of replacement or antedated gravestones. Granite gradually became the stone of choice, and became dominant in the late 1800s. Gravestone style is broadly correlated with stone type: early sandstone and marble gravestones are tablets, whereas marble and granite gravestones are present in a variety of forms. The Greek Revival movement, the development of transportation corridors, and technological advances in carving, grinding, and polishing during the 19th century influenced the choice of stone. Differential weathering of marble gravestones in the cemeteries studied is related to the cemeteries' locations in relation to pollution sources: effects of weathering are most severe in the central city cemetery, and least in the most rural cemetery.

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INTRODUCTION

Workers have approached the study of cemeteries and gravestones in a variety of ways. Traditional studies of gravestones examined the relationship between iconography and theology (for examples see Dethlefsen and Deetz 1966; Ludwig 1966; Coffin 1976; Deetz 1977; Linden 1980; Combs 1986; Moore and others 1991; Keister 1997). Archaeologists and geographers have made other valuable uses of cemetery and gravestone studies. In what are probably the most classic studies of gravestones in North America, Dethlefsen and Deetz (1966) and Deetz (1977) depicted trends in colonial gravestone motifs through time. The results of their work, which illustrated processes by which innovations in material culture emerge, diffuse, and are accepted or rejected by socio-cultural groups, have contributed greatly to archaeological theory. In Florida cemeteries, Dethlefsen (1981) went on to relate gravestone variables and their spatial arrangement to prevailing views of God, intensity of status differentiation, and values of kin. Many archaeologists have developed similar studies since the work of Deetz and Dethlefsen (for one example of a study on the Great Plains see Moore and others 1991). Geographers have viewed cemeteries and gravestones as miniaturizations of the American landscape, noting that changing patterns in cemetery plans reflect cultural phenomena (Price 1966; Francaviglia 1971; Darden 1972). Other studies among the social sciences have assessed the feasibility with which gravestones may be used to obtain demographic, public health, and genealogical data (for some examples see Dethlefsen 1969; Mytum 1980; Ford 1985).

Among the physical sciences, gravestones have proved particularly useful in assessing air pollution and its effects on differential weathering rates. Meierding (1993a) measured surface recession of marble gravestones in 320 cemeteries throughout North America to determine that air pollution is the principal factor in carbonate building stone deterioration. Schreiber and Meierding (1999) used gravestones to show that weathering rates in urban-industrial areas can be as much as eight times greater than those in rural areas. Inkpen and Jackson (2000) analyzed marble gravestones in inland urban, inland rural, coastal urban, and coastal rural localities in the United Kingdom to examine climatic and anthropogenic factors related to weathering. Other examples include the studies of Matthias (1967), Feddema and Meierding (1987), Cooke and others (1995), and Roberts (2000).

As one of the nation's largest industrial cities during the late 19th and early 20th centuries (Orth 1910; Stapleton 1996), and a regionally important city in the settlement of the Great Lakes, Cleveland is an excellent

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location to examine regional cemetery trends and the effects of industrialization on weathering rates. Yet Cleveland area cemeteries have, for the most part, gone unexamined by scholars (see Meierding 1993a and Wanser 1999 for exceptions).

The purpose of this study is threefold: 1) to develop a stone-use seriation pattern for Cleveland area cemeteries; 2) to determine the source of monument stone used in the cemeteries, with an emphasis on the earliest stones; and 3) to assess differential weathering rates among Cleveland area cemeteries. Although this study is largely geologic, we also discuss the relationship between our data and 19th century cultural phenomenon (for example, technological and transportation innovations, prevailing styles, etc.).

METHODOLOGY

Based on age and geographic location, we chose three Cleveland area cemeteries for study: Erie Street Cemetery, Warrensville West Cemetery, and Ridgeville Cemetery (Fig. 1). Erie Street Cemetery (originally known as the City Cemetery) is the oldest existing cemetery within the city of Cleveland. The cemetery is located between East 9th Street (once known as Erie Street) and East 14th Street in downtown Cleveland. Cleveland obtained the land for the cemetery in 1826 and the first burial was in 1827. However, the cemetery includes graves that predate its founding; earlier burials were moved to Erie Street from Cleveland's first cemetery on Ontario Street (Orth 1910, p 147-8). Warrensville West Cemetery, located in Shaker Heights, a suburb east of Cleveland, and Ridgeville Cemetery, a cemetery in North Ridgeville, a suburb west of Cleveland, were included in our study to increase the sampling size and to recognize regional variation in stone use trends and weathering from urban to rural areas. Warrensville West Cemetery is located in Shaker Heights, Cuyahoga County, on Lee Rd. near Van Aken Blvd. According to historical sources its first grave dates to 1811. Ridgeville Cemetery is located on Center Ridge Rd., east of its intersection with Stoney Ridge Rd., in North Ridgeville, Lorain County, OH. This cemetery is the most rural of the three studied.

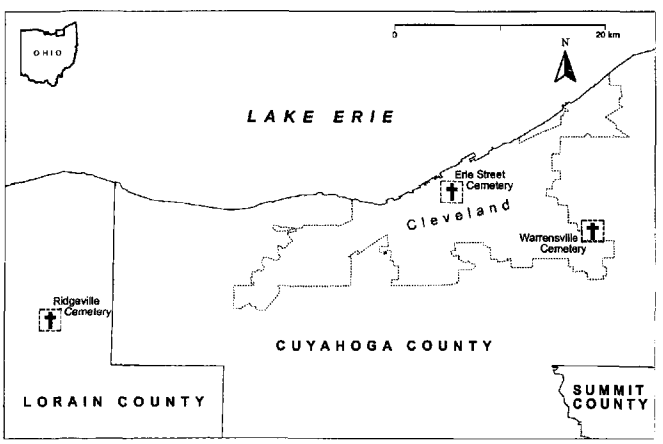

FIGURE 1. Location of three northeastern Ohio cemeteries studied: Ridgeville Cemetery, in North Ridgeville, Lorain County; Erie Street Cemetery, downtown Cleveland, Cuyahoga County; and Warrensville West Cemetery, Shaker Heights, Cuyahoga County.

The first burial in Ridgeville Cemetery, once known as the Center Cemetery (Williams 1879, illustration on page opposite p 157), was in 1813 (Lorain County Historical Society Genealogical Workshop 1980).

Every gravestone in the three cemeteries was examined as part of this study. For each stone we recorded a variety of data including: name and date of death (which we assumed, for the sake of the study, was the date of gravestone erection); location of the gravestone in the cemetery (so that we could recheck data if necessary); rock type and mineralogy; size and style (Figs. 2-4) of the gravestone; and the amount of weathering. Preliminary work on this project was done in 1995, but all data reported here were recorded in the summers of 1999 and 2000. When inscriptions were difficult to read, other sources, including cemetery records and compilations of information made by genealogical groups (for example, Western Reserve Historical Society 1933; Lorain County Historical Society Genealogical Workshop 1980), were used to verify our readings.

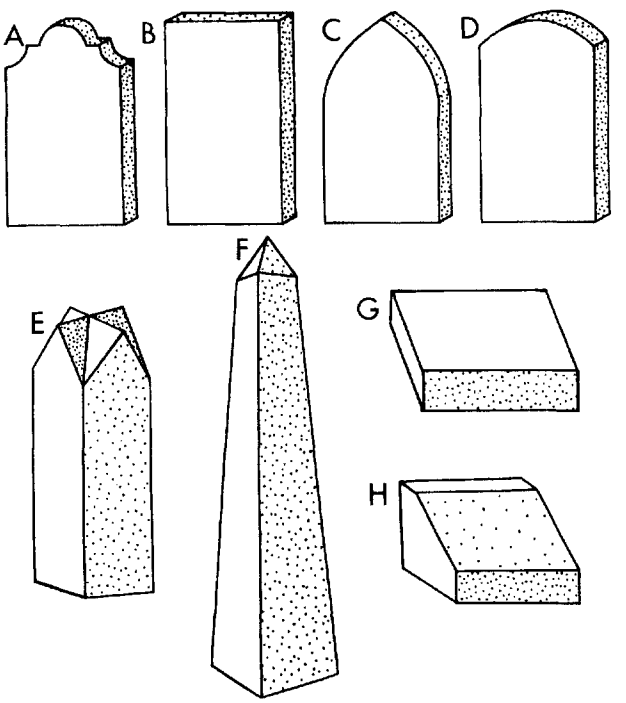

FIGURE 2. Major types of gravestone noted in the text: A) Federal (complex) style tablet, B) rectangular tablet, C) Gothic-point tablet, D) rounded-top tablet, E) cross-vault obelisk, F) obelisk, G) raised-top inscription, H) slant-block. Terminology based on Madden (1974), Froschauer (1988), and other sources.

Rock types were grouped into the following categories: granite, including granite and other coarse-grained igneous rocks; sandstone, including sandstone and coarse siltstone (traditionally called sandstone); limestone; and marble (including only true geological marbles; limestones sold commercially as marbles were classified as limestone). Because there is no one standard for classifying grain sizes of all types of rocks, grains were measured using a grain-size card in standard

FIGURE 3. Sandstone tablet of Joel Terrel (d. 1825) at Ridgeville Cemetery. This gravestone, fashioned in the Federal style, is in good condition but is exfoliating at places including along crests of ripples.

sedimentary ranges as outlined by Compton (1985, table 4-1). Measurements below are given in these standard units, usually in μ (micron) increments. In some cases, we have used "upper" and "lower" to distinguish subsets of categories. Thus a very fine grain size would be divided into a lower very fine grain size

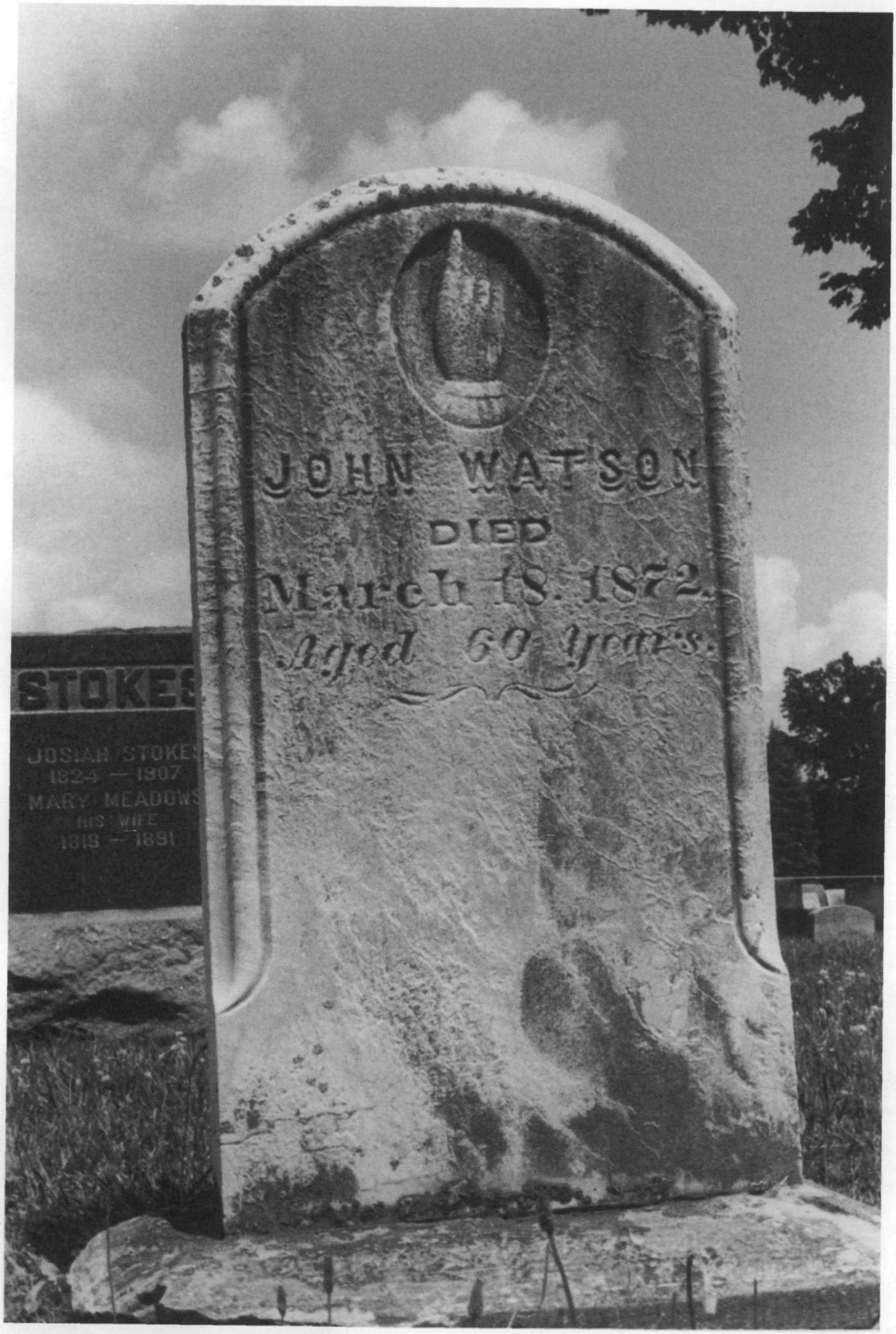

FIGURE 4. Marble, rounded-top tablet of John Watson (d. 1872) at Ridgeville Cemetery.

and an upper very fine grain size.

Gravestone weathering was recorded using an inscription legibility method outlined by Meierding (1993b) that we subsequently refer to as the Meierding Scale. This is a visual scale based on type photographs with values ranging from 0 to 11, 0 being no evidence of weathering

and 11 being no remaining trace of an inscription. Only monuments with inscriptions at least 50 cm above the ground and 10 cm from the monument's edge are assessable with the Meierding Scale.

Gravestones—that is, stone markers, headstones, or monuments (Figs. 2-4) used to mark a grave or memorialize one or more persons—were grouped by style into family monuments (principal monuments standing for three or more burials) and individual plot gravestones (single, joint gravestones for husbands and wives included). Among the family monuments, we recognized obelisks, cross-vaulted obelisks, large blocks, pulpits, and a variety of other elaborately carved forms. Individual gravestones were regularly recorded as tablets (Figs. 3,4), rounded blocks, squared blocks, slanted blocks, raised-top blocks, scrolls, and lawn plaques. Tablets were subdivided into additional categories: rectangular tablets (squared tops and sides), rounded (Romanesque) tablets, Gothic-point tablets, and complex-topped tablets that often combined squared or other types of shoulders with a variety of rounded carvings on the top. Following precedent, we refer to the complex-topped tablets as being in the Federal style. Such complex gravestones, which actually have antecedents in ancient Greece, have been referred to as belonging to the Georgian and Federal styles (Madden 1974, p 150). (For other examples of monument styles see Moore and others 1991, and Dethlefsen 1981.)

Provenance for early stone was explored by comparing samples from local outcrops to gravestones. Historical records (especially advertisements in newspapers and city directories) were also utilized in approximating stone provenance.

Data were coded and compiled in an Excel spreadsheet. Statistical mean and regression analyses were performed with Excel's Analysis ToolPak and a standard TI-83 calculator.

RESULTS

The data from the three cemeteries studied are discussed below, arranged by the west-to-east geographical position of the cemeteries.

Ridgeville Cemetery: Stone and Form

We examined 1,090 gravestones at Ridgeville Cemetery. Of the total, 778 (71.38%) were granite, 266 (24.40%) were marble, 23 (2.11%) were bronze, 20 (1.83%) were sandstone, 2 (0.18%) were limestone, and 1 (0.1%) was concrete (Fig. 5a). Death dates, ranging in time from 1813 to 2000, were present and legible on 1,007 (92.39%) tombstones, allowing us to establish a seriation curve for stone use in the cemetery (Fig. 6).

A fine-grained sandstone is the earliest stone used for gravestones (Fig. 3) at Ridgeville Cemetery. Although there are only 20 sandstone gravestones present in the cemetery, 16 contain death dates between 1813 and 1840 (two sandstone gravestones do not contain death dates and the remaining two are outliers, dating to 1925 and 1984, respectively). Sandstone comprises 100% ($n = 3$) of all the gravestones in the cemetery that show death dates between 1810 and 1820, and more than 66% ($n = 9$) of the

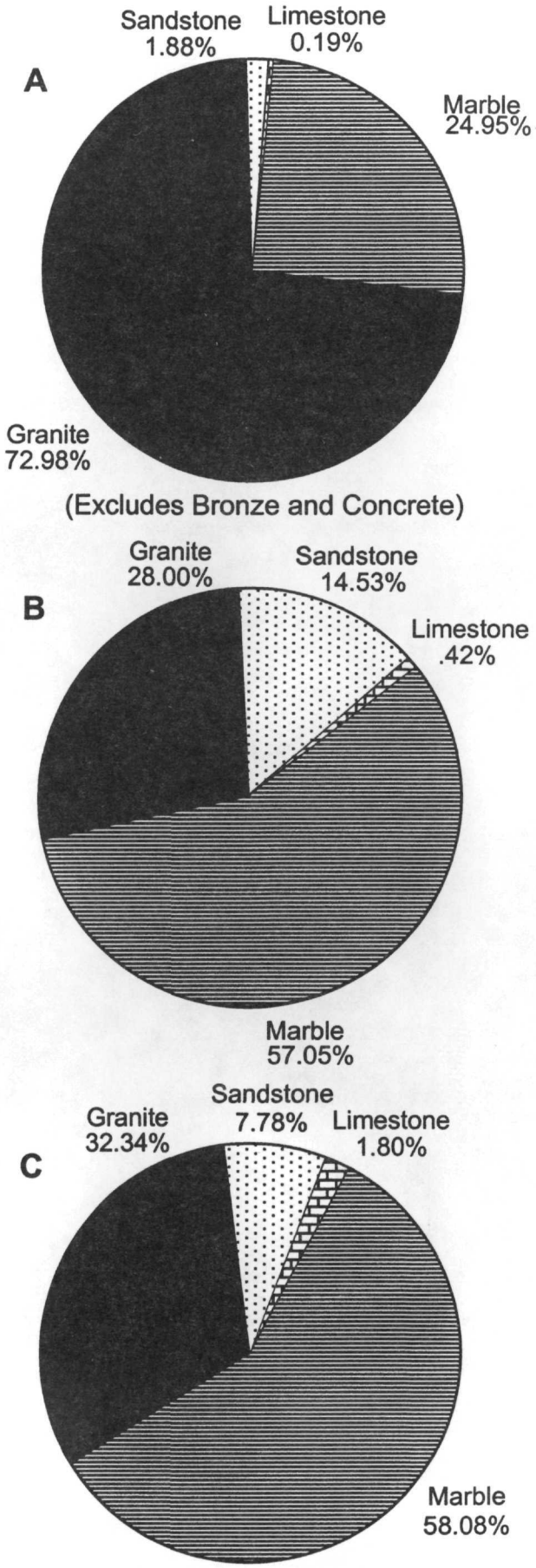

FIGURE 5. Percentage of stone types at: A) Ridgeville Cemetery, B) Erie Street Cemetery, and C) Warrensville West Cemetery.

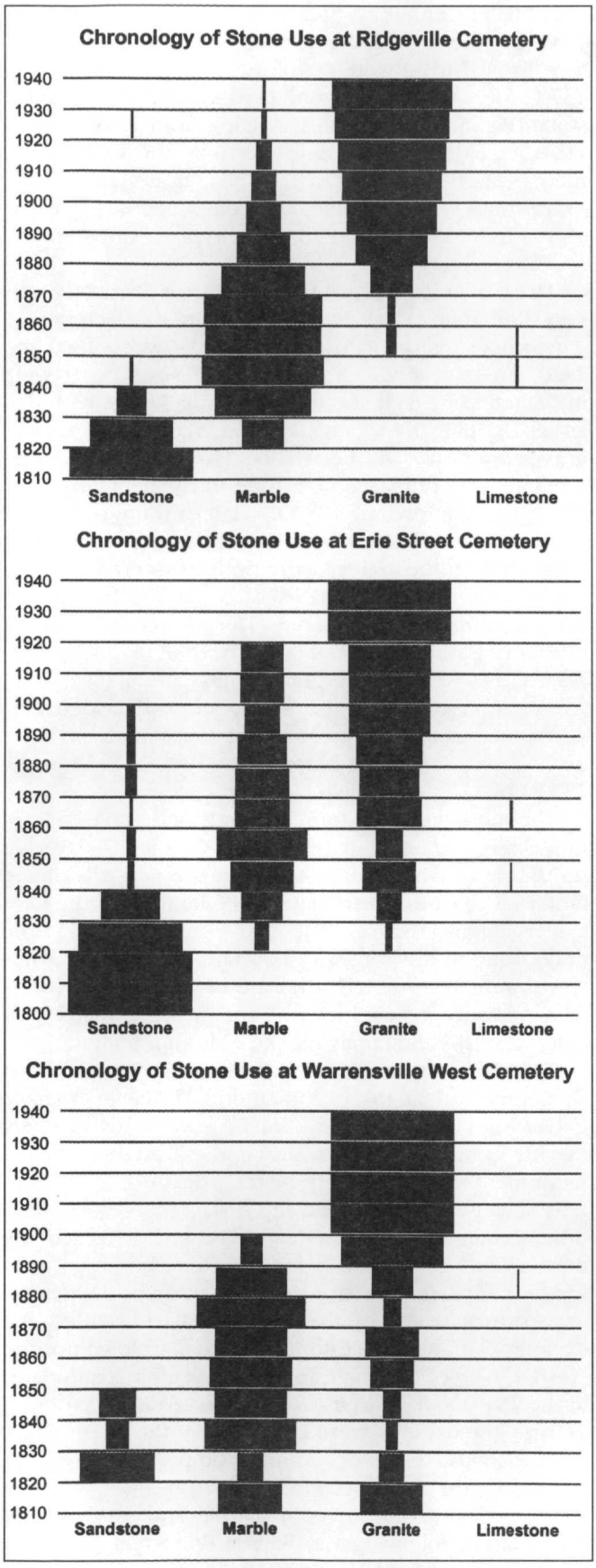

FIGURE 6. Stone type seriation curves for Ridgeville Cemetery, Erie Street Cemetery, and Warrensville West Cemetery. Except for a single very obvious stone at Erie Street Cemetery, graphs do not exclude replacement stones. Stones dated after 1940 are not included; the vast majority of those stones are granite.

gravestones between 1820 and 1830. The use of marble apparently began in the 1820s and increased in the cemetery during the 1830s, as the use of sandstone as a gravestone began to wane (but see discussion on antedated marble gravestones below). In the 1830s only 19% (n = 31) of the gravestones were sandstone, and in the subsequent decade the percentage dropped to only 3% (n = 32) of the total gravestones. Measured grain sizes from the sandstone gravestones include 3 gravestones with grain sizes from 62 to 88 μ, 9 from 88 to 125 μ, 1 from 125 to 177 μ, and 3 from 177 to 250 μ.

The early sandstone gravestones present in Ridgeville Cemetery are exclusively tablets. The 5 earliest tablets in the cemetery (ranging in date from 1813 to 1825) are Federal style. Of the remaining 11 sandstone gravestones that predate the 20th century, 10 are true rectangular tablets and 1 is another example of the Federal style (Fig. 7). The last sandstone tablet at Ridgeville Cemetery has a death date of 1840.

In the decades following the replacement of sandstone by other stone as the primary gravestone, sandstone continued to be used as a monument base. In the 1840s, 45% (n = 31) of all marble gravestones had sandstone bases. In the 1850s, 49% (n = 49) of the total gravestones had sandstone bases, and by the following decade the same figure was over 61% (n = 54). During the 1870s and 1880s sandstone was used as a base for 32 of 78 gravestones (41%) (20 of 47 and 12 of 31, respectively). At the end of the century there was a precipitous drop in the use of sandstone as a gravestone base. During the last decade of the 19th century and the first decade of the 20th century, sandstone was used as a base for only 5 of 90 (6%) gravestones (2 of 37, and 3 of 53). Only 3 of the more than 750 gravestones postdating 1910 at Ridgeville Cemetery have sandstone bases.

Marble (Fig. 4) replaced sandstone as the chief stone for gravestones relatively abruptly and remained dominant in the cemetery for several decades. The earliest date on a marble gravestone at Ridgeville Cemetery is 1826. Yet, by the 1830s, marble comprised more than 80% of the gravestones for that decade. Marble's dominance at Ridgeville Cemetery continued throughout the middle part of the 19th century. Marble made up more than 85% (n = 170) of the gravestones between 1840 and 1879. It was not until the 1880s that marble comprised less than half of a decade's gravestones, at which time granite began to dominate.

Marble gravestones at Ridgeville Cemetery take a variety of forms. The most prevalent early marble forms are rectangular tablets, comparable to the sandstone variety they replaced. By the 1850s, pointed-arched Gothic style tablets and rounded-top tablets began to replace the strictly rectangular forms (Fig. 7). Family monuments such as obelisks also appear at this time. Toward the latter part of the century, as family monuments began to prevail, the use of granite as a monument stone increased.

Compared to the transition from sandstone to marble, the shift from marble to granite was gradual. Although the earliest evidence of granite at Ridgeville Cemetery is a large family block with an 1852 date of death, there

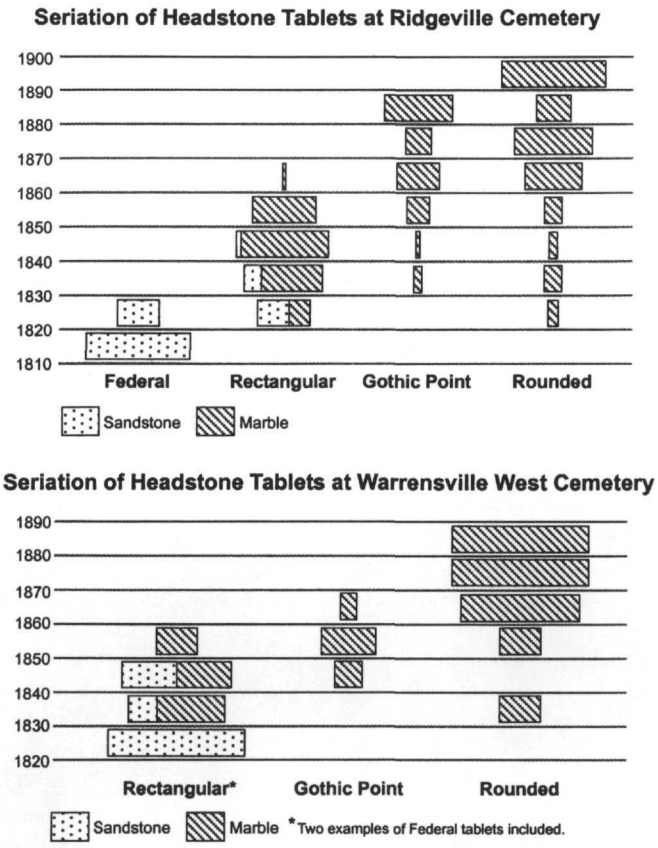

FIGURE 7. Seriation of headstone tablets at Ridgeville Cemetery and Warrensville West Cemetery.

are only 5 granite gravestones (all of them family blocks or obelisks) that predate 1870. Granite did not begin to dominate until the latter decades of the century. In the 1870s granite comprised only 34% (n = 47) of the decade's monuments. In the subsequent decades, granite's percentage for the decades' totals increased to 56% (n = 32), 73% (n = 37), 81% (n = 53), 86% (n = 44), and 96% (n = 56), all but phasing marble out in the 1930s, when granite comprised 98% of the decade's totals and marble only 2% (n = 61). Since 1931 eight marble gravestones have been erected at Ridgeville Cemetery, the latest of which bears a death date of 1979. In contrast, since 1940, 480 of the 509 (94%) gravestones erected in the cemetery have been granite, typically taking the forms of family blocks, slant blocks, rounded blocks, scrolls, and raised inscriptions.

A variety of other materials have been used as gravestones at Ridgeville Cemetery; however, only bronze is displayed with the regularity and concentration seen in the use of sandstone, marble, and granite. Nineteen bronze lawn plaques were placed in the cemetery between 1960 and 1999. Of the remaining bronze plaques, two are not dateable and two others have death dates of 1882 and 1919. Aside from the bronze plaques, two limestone monuments are present in the cemetery; both are family monuments dating to 1853 and 1860, respectively. Lastly, there is one example of a concrete gravestone that does not record the date of death.

Erie Street Cemetery: Stone and Form

Of the 943 recorded gravestones at Erie Street Cemetery, 538 (57.05%) were marble, 264 (28%) were granite, 137 (14.53%) were sandstone, and 4 (0.42%) were limestone (Fig. 5b). Death dates, ranging from 1797 to 1974, were legible on only 531 (56.31%) of the total monuments. Marble comprised 79.85% (n = 412) of the gravestones lacking legible death dates and is, therefore, a greatly underrepresented stone type in the seriation for the cemetery.

The earliest stone used at Erie Street Cemetery was very fine-grained sandstone. All of the cemetery's 16 gravestones that contain death dates between 1800 and 1820 are sandstone. Of these, grain sizes on 9 were measured as 62-88 μ and the remaining 7 were recorded as 88-125 μ. Early death dates on marble and granite gravestones are in the 1820s. However, sandstone remained the primary gravestone in the cemetery until the 1840s, comprising 84% (n = 19) of the monuments of the 1820s and 48% (n = 40) of the gravestones of the 1830s. In the 1840s, a precipitous decrease in the use of sandstone coincided with a marked increase in the use of marble and granite. Decade totals include 4 (5%) sandstone gravestones, 39 (50%) marble gravestones, 34 (44%) granite gravestones, and 1 (1%) limestone gravestone. In the subsequent five decades, sandstone retained a presence in the cemetery; however, it never comprised more than 10% (5 of 54 in the 1870s) of a decade's totals.

The most prevalent form of sandstone gravestone in Erie Street Cemetery is the tablet. Of the 77 dateable sandstone gravestones in the cemetery, 65 (84%) are tablets. The earliest varieties are Federal style; the later are rectangular tablets. The first non-tablet sandstone gravestone in the cemetery is a family plot with sandstone walls bearing a death date of 1834. Other forms of sandstone gravestones present in the cemetery include obelisks and family blocks, although both are rare.

The introduction of marble and granite at Erie Street Cemetery appear to be coincident. However, marble gravestones outnumbered granite gravestones in every decade until the 1860s. The earliest legible marble monument in the cemetery bears a death date of 1825, only four years earlier than the first granite block. (Another granite block with a death date of 1797 is actually the "earliest" gravestone in the cemetery, but it is a very obvious replacement stone.) However, the 13 marble gravestones (33%) of the 1830s nearly doubled the decade's 8 granite gravestones (20%). Marble comprised 50% (n = 78) of the gravestones with legible death dates in the 1840s and 71% (n = 70) in the 1850s. In contrast, granite gravestones were only 21% of the 1850s total. By the 1860s, however, granite comprised more than half (23 of 43) of the decade's gravestones.

Granite outnumbered both marble and sandstone in every decade following the 1860s at Erie Street Cemetery; but marble maintained a strong presence in the cemetery until the beginning of the 20th century. In the 1870s, 48% of the gravestones were granite and 43% were marble (n = 54). In the 1880s, granite comprised 54% of the decade's gravestones and marble 39% (n = 80). There

was not a marked decrease in marble's use at Erie Street Cemetery until the 1890s, when the stone made up only 28% of the decade's monuments and granite 66% (n = 76). In the first two decades of the 20th century the ratio of marble to granite remained relatively constant. Marble comprises 10 of the 29 gravestones bearing death dates between 1900 and 1909; the remaining 19 are granite. Likewise, of the 6 monuments dating to the 1910s, 2 are marble and 4 are granite. The latest legible date of death on a marble gravestone at Erie Street Cemetery is 1912. All of the cemetery's gravestones dated after the 1910s are granite.

Marble and granite gravestones at Erie Street Cemetery are present in a variety of forms. The most common varieties of marble gravestones in the cemetery are rectangular tablets, rounded tablets, Gothic-point tablets, obelisks, and cross-vaulted obelisks. Granite was also used for obelisks and cross-vaulted obelisks, as well as large family blocks, scrolls, and other forms. Two legible limestone obelisks are also present in the cemetery, bearing death dates of 1843 and 1866.

Warrensville West Cemetery: Stone and Form

At Warrensville West Cemetery we documented 167 gravestones. Of this number, 97 (58.08%) were marble, 54 (32.34%) were granite, 13 (7.78%) were sandstone, and 3 (1.80%) were limestone (Fig. 5c). Death dates at Warrensville West Cemetery ranged from 1812 to 1955. A great percentage of the gravestones no longer had legible dates. Of the cemetery's total, 66 (39.52%) had either an illegible date inscription or, possibly, were never marked. The high percentage of illegible stones, when coupled with the relatively small size of the cemetery, greatly inhibits the development of a strong stone-use seriation curve (Fig. 6). Obvious replacement monuments further complicate the cemetery data.

One of the two gravestones dating to the second decade of the 19th century is a marble tablet, and the other is a granite raised-top inscription. A conspicuous lack of weathering on the marble tablet (6 on the Meierding Scale) and the style of the granite monument suggest that both of these gravestones are later replacements. The earliest sandstone tablet bears a death date of 1824. Sandstone comprised 60% (n = 5) of the gravestones erected in the 1820s, 18% (n = 11) in the 1830s, and 29% (n = 7) in the 1840s. The latest death date on a sandstone gravestone at Warrensville West Cemetery is 1843. The earliest sandstone gravestones at Warrensville are Federal style and later ones are rectangular tablets (Fig. 7).

Marble is the dominant stone for the majority of the 19th century at Warrensville West Cemetery, although granite gravestones are present in every decade (many of the early examples are likely replacement stones). In the 1830s marble comprised nearly 73% (8 of 11) of the decade's gravestones. In the ensuing three decades marble's percentage fluctuated between 57% and 65% (4 of 7, 11 of 17, and 8 of 14, respectively) before peaking at 86% (n = 7) in the 1870s. However, in the latter decades of the century there was a precipitous drop in the use of marble and a relative increase in the use of granite at the cemetery. By the 1880s, marble's percentage of the decade totals decreased to 56% (n = 9) and granite's increased to 33%. Granite's percentage further increased to 83% (n = 6) in the 1890s. All 23 of the cemetery's gravestones postdating 1892 are granite.

Marble and granite gravestones at Warrensville West Cemetery are present in several forms. The tablet is the most prevalent form among the marble gravestones and a convincing seriation curve can be drawn for its three varieties (Fig. 7). With a last occurrence dating to 1856, 75% (n = 12) of the dateable rectangular marble tablets in the cemetery occur before 1850. Among the Gothic-point tablets, 5 of 6 (83%) bear death dates between 1852 and 1862. Lastly, 73% (n = 22) of the dateable rounded tablets occur after 1860. Other marble gravestones at Warrensville West Cemetery include obelisks and cross-vaulted family monuments. Granite forms include obelisks, large family blocks, slant blocks, rounded blocks, scrolls, and raised-top inscriptions.

Three limestone monuments are present in Warrensville West Cemetery. One contains a death date of 1885; the other two are illegible. Two of the three are family obelisk style monuments and the third, composed of Indiana limestone, is carved in the shape of a tree-trunk.

STONE PROVENANCE

Most of the sandstone gravestones at Erie Street Cemetery, Ridgeville Cemetery, and Warrensville West Cemetery have local sources. Precise historical information on the earliest quarries is scant, although we know that the early Cleveland stone cutter Abel Garlick (see Anonymous 1996 for information on Garlick's brother, another early stonecarver) used stone from the quarry of Dr. D. Long (Butler 1963, p 140), an early Cleveland physician. The grain sizes of many of the earliest gravestones at Erie Street Cemetery are in the very fine sand size ranges. Grain size and color (as seen on areas of the gravestones that are chipped) suggest that at least some of the stone is Euclid bluestone (sandstone from the Euclid Member of the Bedford Formation). Euclid bluestone crops out in central and eastern Cuyahoga County (Cushing and others 1931; Pashin and Ettensohn 1995; Fig. 7). In the 19th and early 20th century, Euclid bluestone was quarried in many places in eastern Cuyahoga County, notably areas now on the east and southeast sides of Cleveland and in South Euclid. It was well known for its use in flagging (Newberry 1873, p 188-9). Flagging, like tombstones, traditionally requires easily split, flat-bedded rocks. A likely quarry area for the fine-grained stone seen at Erie Street Cemetery is old Newburg, one of the earliest quarry areas in Cleveland (Whittlesey 1838, section between p 56 and 57, p 57; Bownocker 1915, p 70-2). Abel Garlick was known to use stone quarried in the Mill Creek area (Avery 1918, p 689) in old Newburg. Samples from this early quarry area (near the waterfall along Mill Creek, now part of Cleveland) closely resemble, in both color and grain size, some of the early gravestones at Erie Street Cemetery.

Based on color and grain size, most of the sandstone used in Erie Street Cemetery and almost all of that used

in the other two cemeteries is Berea Sandstone. Most of the sandstone at Erie Street Cemetery and all of the sandstone at Ridgeville Cemetery and Warrensville West Cemetery is in the upper fine, to medium, grain size; some is in the coarse-grain range. The grain size of the Berea overlaps with that of the Euclid bluestone, but the Berea in northern Ohio is generally coarser grained than the Euclid and typically has rounded reddish-brown spots (see Hannibal 1998, p 14-5) that the Euclid lacks.

The Berea has been, and is, the most important and widely quarried dimension stone in northeastern Ohio (Newberry 1873, p 187-8; Read 1879, p 215; Bownocker 1915). It was quarried in several localities just east and south of Cleveland, and near North Ridgeville at Columbia Station, as well as at other locales in western Cuyahoga County and in Lorain County, in the 1800s and early 1900s (Williams 1879, p 157; Bownocker 1915). It is likely that finer grained Berea (and the local Euclid bluestone) were preferentially selected, as these fine grained sandstones resembled the slates and other fine-grained stones used for gravestones in New England (although other stones were also used there, see Sweeney 1985). The preference for fine-grained rocks for gravestones is also shown by the popularity of Buena Vista sandstone (a siltstone known as a freestone) used for early gravestones in southern and middle Ohio (Wied-Neuwied 1906, p 147) and of the Hindostan whetstone (also a siltstone) used extensively in southern Indiana (Kvale and others 2000).

The small quantities of limestone that are evident among the three cemeteries have a variety of sources. The most common type was a gray, fossiliferous, Middle Devonian limestone used for a few monuments and one mausoleum in Erie Street Cemetery. Based on the fossils present, including rugose corals and tentaculites, that limestone is either Columbus or Delaware limestone, and was probably quarried in the Sandusky area, in Sandusky County, OH. Tennessee "marble," a pink bryozoan/crinoidal limestone from the Holston Formation of eastern Tennessee is also evident in Erie Street Cemetery and Ridgeville Cemetery. Two tree-shaped family monuments, one in Ridgeville Cemetery and one in Warrensville West Cemetery, were carved from Salem Limestone (known commercially as Indiana limestone) from south-central Indiana.

Marble is difficult to source macroscopically. Abundant historical advertisements and texts, however, indicate the marble belt of Vermont and the Carrara area of Italy as the likely provenances for most of the marble used in Ridgeville Cemetery, Erie Street Cemetery, and Warrensville West Cemetery. Both Vermont and Carrara marbles can be similar in color and grain size (as opposed, for instance, to the coarser grained Georgia marble). Provenance could be determined using petrographic techniques coupled with isotopic analysis as Vermont and Massachusetts marbles have isotopic signatures distinct from that of Carrara marble (see Dooley and Herz 1995), but such analysis requires destructive testing beyond the scope of this study.

The transition from sandstone to marble can be inferred from the advertisements of stone carvers. The advertisements of Thomas Jones, a stone carver who established a business in Cleveland in 1831, are particularly noteworthy. His advertisement in the *Cleveland Herald* (1 February 1834, p 3) noted that he produced gravestones, windowsills, doorsteps, and other products. Jones most likely worked with sandstone, because extant early Cleveland windowsills and doorsteps are sandstone. Not long after (*Cleveland Herald*, 15 February 1834, p 3), however, Jones changed his ad to note, "He keeps constantly on hand an assortment of Marble, as well as the other kind of stone [certainly sandstone] commonly used." This is the earliest historical record indicating marble use that we have found. Thus the first use of marble may be in the 1830s, and some marble gravestones may be antedated.

Thomas Jones & Sons' Cleveland Marble Factory on Seneca Street became a prime supplier of marble tombstones; their ad in the 1845 city directory emphasized American and Italian marble, noting that, for the last 15 years, they had supplied "all" of the marble for the city cemetery (Erie Street Cemetery) (Sanford & Hayward 1845). Furthermore, in an 1848 ad, emphasis was placed on their "superb Italian marble headstones" (Smead and Cowles 1848). Indeed, advertisements for marble gravestones are abundant in Cleveland newspapers and directories in the 1840s and 1850s. Early advertisements in Cleveland newspapers for the Eagle Marble Works (advertisement in *Cleveland Herald*, 3 January 1845; 1845 *Cleveland Directory*), the Myers, Uhl, and Co.'s Steam Marble Works (Spear, Denison and Company 1856), and DM Vanerpool & Co.'s Marble Warehouse (advertisement in *Cleveland Herald*, 11 August 1847) stressed the carving of both American and Italian (sometimes advertised simply as "foreign") marble. Advertisements in city directories for other larger towns document the use of "foreign and American" marble (Cincinnati, Williams 1851; also well documented in city directories for Toledo, Buffalo, and other cities). Kallas (1983) has documented similar marble ads in the 1840s through 1880s for Portage County, WI.

Vermont was, and is, a great center of marble production in the United States. *The Marble-Workers' Manual* (Booth 1865) referred to it as the Marble State. Dorset, VT, quarries produced their first gravestone in 1790 (Merrill 1891, p 107), while limited production of gravestones from Massachusetts also occurred in the 1790s (Sweeney 1985, p 33). According to Merrill (1891, p 5-6), Italian marble was first introduced in New England in the 1840s, and by 1855 competition from Vermont and Italian marble caused Massachusetts quarries to close, allowing the Vermont and Italian varieties to dominate the market.

Stone provenance of early granite gravestones in Erie Street Cemetery, Ridgeville Cemetery, and Warrensville West Cemetery include several New England quarries. Many of the earlier granite monuments in the three cemeteries were easily recognized as light gray Barre granite (technically a granodiorite) or gray Quincy granite (also a granodiorite) by their mineral composition, grain size, and coloration. The Barre granite industry took off only after the Civil War, with a shift of monument stone

preference from marble to granite (Richter 1987, p 242). By the 1870s advertisements for granite works appear (advertisement of New England Granite Works, Hartford, CN, in the *Cleveland Leader*, 14 August 1875). A stone carver's advertisement in Evert's 1875 (p 83) atlas of Montgomery County (southwestern Ohio) includes the caption "Scotch & Quincy granite monuments & manufacturers of monuments & grave stones," supporting identification of New England granite in Ohio. By 1880 Thomas Jones Jr. (who had taken over his father's business) had expanded his inventory to include granite, and advertised his Steam Marble and Granite Works (Reese 1880, p 67). Likewise, Lake View Granite Works in Cleveland produced gravestones in both granite and marble in the 1880s (Anonymous 1886, p 84).

Granite eventually became the cemetery stone of choice. Some cemeteries in northeastern Ohio no longer allow marble, except as a replacement stone. Many types of granite in addition to Barre and Quincy have been used in the three cemeteries, but a detailed analysis of the granites was beyond the scope of this project.

WEATHERING

Differential weathering among Ridgeville Cemetery, Erie Street Cemetery, and Warrensville West Cemetery is shown by the percentage of legible marble gravestones in each. At Ridgeville Cemetery, 82.71% (220 of 266) of the marble gravestones contain a legible date of death. In contrast, only 38.66% (208 of 538) of the marble gravestones at Erie Street Cemetery have legible death dates. This figure increases somewhat at Warrensville West Cemetery, where 46.39% (45 of 97) of the marble gravestones are still legible.

Classifying marble gravestones into dichotomous "legible" and "illegible" categories allows for a general assessment of the degree of weathering at each cemetery; however, more can be gleaned from the weathering data by statistically analyzing the Meierding Scale results. At Ridgeville Cemetery, 161 marble gravestones met the criteria for Meierding photographic scale assessment and yielded a mean value of 6.61 (σ = 2.01). At Erie Street Cemetery, 288 assessable marble gravestones produced a mean of 8.78 (σ = 1.59). At Warrensville West Cemetery, 69 marble gravestones had a mean of 7.00 (σ = 2.16). Using a two-sampled Z-test (H_0: μ_1-μ_2 = 0, H_1: μ_1-μ_2 <0) the Ridgeville mean Meierding value (z = -11.815) and the Warrensville mean value (z = -6.437) are lower than that of Erie Street at the 99% confidence level. In comparing the Ridgeville mean to the Warrensville mean, H_0 is only tentatively rejected at the 90% confidence level (critical value = -1.28, z = -1.285). The results of the statistical tests suggest that, according to the Meierding Scale, weathering has had a markedly greater affect in Erie Street Cemetery than in Ridgeville Cemetery and Warrensville West Cemetery. Likewise, weathering has been greater in Warrensville West than in Ridgeville Cemetery, although not in such a definitive manner. This pattern is what one might expect with prevailing westerly winds carrying pollutants from the industrial center of Cleveland to the east (see discussion below).

Simple linear regression analysis among the three cemeteries suggests that there is a weak relationship between the age of a marble tablet and the amount of weathering it displays at Ridgeville Cemetery; but that no relationship exists between the two variables at Erie Street Cemetery and Warrensville West Cemetery (Fig. 8). Using the Meierding value as a response variable to the death date (explanatory variable), analysis of the assessable tablets at Ridgeville Cemetery generated a coefficient of determination of .292 (r = 0.54). In contrast, Erie Street data produced a punitive .0067 coefficient of determination (r = 0.082). Tablet weathering data from Warrensville West Cemetery yielded a similarly

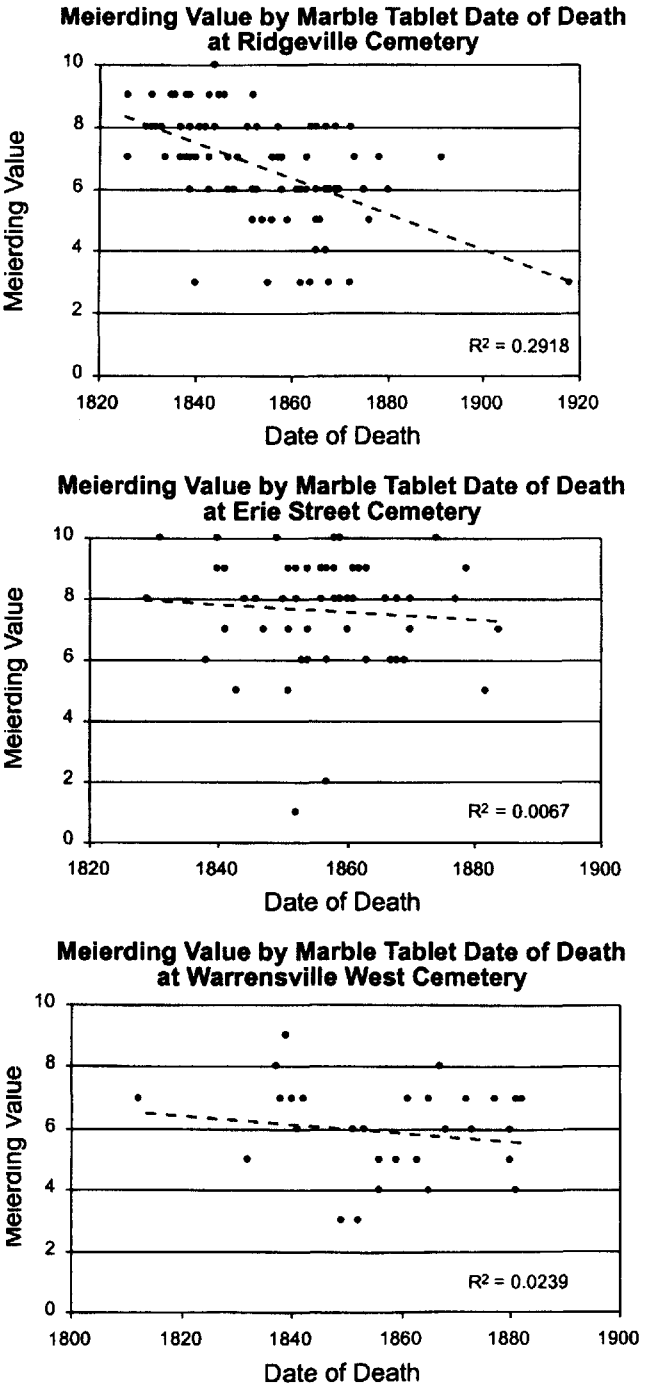

FIGURE 8. Meierding value by marble tablet date of death.

low 0.024 coefficient of determination ($r = 0.155$). That Erie Street and Warrensville West regression analysis generated low r and r^2 values suggests that the amount of weathering displayed by a marble tablet is not explained by its age. Although relatively higher r and r^2 values for the Ridgeville data identify a relationship between Meierding value and date of death (age), results were still low by statistical standards and don't preclude that other variables may be a better predictor of the amount of weathering a gravestone displays.

DISCUSSION

With a few exceptions, the earliest gravestones in the United States were carved from locally available stone. Slate and other local metamorphics, for instance, were used in the Boston area before marble was introduced. In Ohio, sandstone (that is, stone traditionally called sandstone, but technically including both sandstone and siltstone) was used for most of the earliest stone gravestones (for example, Briggs 1838, p 147; Stout 1944, p 88). As noted above, Euclid bluestone and Berea Sandstone were the dominant types of stone quarried in the Cleveland region. However, in a large region of southern and central Ohio, Buena Vista sandstone (technically a siltstone) was used (Hannibal 1998; Wied-Neuwied 1906, p 147). Other sandstones were used to a more limited extent in Ohio; the "Waverly" sandstone is one example (Orton 1874, p 623).

Local sandstone was dominant in the Cleveland area in the first decades of the 19th century. The seriation curves for Ridgeville and Erie Street cemeteries show this clearly (Fig. 6). The lack of early sandstone at Warrensville West Cemetery when compared to the other two cemeteries may be partly attributable to legibility problems and cemetery size. Of the 13 total sandstone gravestones at Warrensville West Cemetery, 6 (46%) have illegible death dates. In contrast, at Ridgeville only 2 (10%) of the sandstone gravestones lack a legible death date. Furthermore, the 944 total gravestones at Erie Street Cemetery (137 of which are sandstone) dwarf the 167 total at Warrensville West Cemetery. Early advertisements (see stone provenance, above) offer additional evidence for early sandstone use.

There was a rapid shift in the Cleveland area during the fourth decade of the 19th century from using local stone to using imported stone for carving gravestones. Marble gravestones with dates in the 1820s are present in all three cemeteries. However, ads for marble in Cleveland newspapers indicate that marble tombstones were introduced in the area in the 1830s. The situation is similar in other areas of Ohio: Hawley (1996, p 32) has shown that R. Putnam's gravestone in Marietta, made of marble and dated 1824, may have been carved in Pittsburgh in the 1830s (see Slater and Tucker [1990] for further information on interpreting antedated tombstones). By the 1840s, at all three cemeteries studied, marble made up a greater percentage of gravestones than did local sandstones. This transition from local stone to imported stone is not exclusive to the Cleveland area, or even the Midwestern US, and it is undoubtedly related to larger scale culture preferences, developments in transportation, and to some extent, stone-working technology.

Our data, as well as historical advertisements, suggest that marble was imported for gravestones before granite. At Ridgeville Cemetery, where there is the greatest percentage of legible stones, the case is unequivocal; the earliest marble gravestone predates the earliest granite monument by nearly 30 years (Fig. 6). Moreover, historical advertisements for marble gravestones occur in Cleveland newspapers and directories (see stone provenance above) at least by 1834. In contrast, the earliest advertisements for granite gravestones are in periodicals dated to the 1870s. Even as late as 1880, the Harsha's Marble and Granite Works of Hillsborough, Highland County in Chillicothe sold American and foreign marble and granite for gravestones, but was incapable of turning or polishing granite (Williams Bros. 1880, p 368).

That the introduction of marble before granite is more ambiguous at Erie Street and Warrensville West cemeteries may be related to weathering, number of replacement stones, and our methodology. High percentages of illegible marble monuments exist at Erie Street and Warrensville West; hence marble is underrepresented in the seriation curves. Therefore, in the middle decades of the 19th century, when marble's use likely dwarfed that of granite, the two stones appear to have been used equally. Obvious replacement stones, when coupled with a small data set, also skew the seriation curve at Warrensville West Cemetery. Because of small sample sizes, one granite replacement monument dated to 1812 represented 50% of the decade's total; and only one granite monument in each of the next three decades comprised 20%, 9%, and 14% of the decades' totals. In Erie Street Cemetery, the more than 50 granite monuments that predate the 1870s are probably not all replacement stones; however, stylistically many of them could be. Lastly, because we recorded the earliest date of death on each principal monument, and not all monuments could be checked with historical records, our methodology undoubtedly allowed many early granite monuments (which are often family monuments and contain more than one date of death) to appear earlier than their actual date of erection, confusing the non-contemporaneous introduction of marble and granite.

Marble's replacement of local sandstone in the Cleveland region, as well as local stone in many other parts of Ohio and the United States during the 19th century was due to a number of reasons, including: 1) the popularity of the classic Greek model for many things, ranging from politics to architecture; 2) the advantageous position of Vermont and Carrara marble quarries in relation to water transport; and 3) the ease of cutting and carving marble compared to other materials, especially using mid-nineteenth century technology.

The Greek Revival movement was a major factor in the popularity of marble tombstones during the 19th century. The movement, which was sparked in part by classical education emphasizing Greco-Roman texts (Post 1835), the West's support of the Greek War of

Independence, and scholarly interest in excavations and ancient Greek artifacts, lasted a long time in the United States (McDowell and Meyer 1994, p 23-4; Sloan 1991, p 41). Marble became, and still is, closely associated with classical civilization (Sloan 1991, p 41). The Revival movement initiated an interest in the use of marble for a variety of purposes, largely because the ancient Greeks used marble for building stone, statues, and monuments of every sort, including tablet-shaped cemetery stelae. As a result, Greek motifs became widely popular and remained so into the 20th century in North America north of Mexico.

As the Greek Revival movement flourished, developments in transportation greatly facilitated the movement of marble to the Cleveland region and the rest of Ohio. Transportation via New York's Erie Canal (completed in 1825) and the Champlain Canal (completed in 1827 but navigable utilizing the Hudson River as early as 1822) was essential for the success of southwestern Vermont products (Collins 1916, p 145; Russell 1991, p 25). The earliest marble tablets at Erie Street Cemetery and Ridgeville Cemetery bear death dates of 1825 and 1826, respectively, the year of, and the year after, the completion of the Erie Canal. These stones may be replacements, however (see above). After the completion of the Erie Canal and of the Ohio & Erie Canal (1825-1834), Cleveland, OH, because of its location on Lake Erie and at the northern terminus of the Ohio & Erie Canal, became an important distribution hub for marble (Fig. 9; Hannibal 1998, p 11-2, tables 2,4). Goehner's Marble Works in Chillicothe, established in 1866, obtained its marble, "mostly Italian," from Cleveland (Williams Bros. 1880, p 206). Moreover, toll rates for marble, both as blocks and "manufactured," are included on lists of canal boats that traveled on the Ohio, Hocking, and Walhonding canals (Board of Public Works 1853). The construction of a pier in Marina di Carrara, the port of Carrara, Italy, in 1851, made efficient loading of marble onto ships possible, thus expediting the export of Carrara marble. Previously, the marble had been loaded onto boats after they had been beached. Italian marble was shipped to Cleveland via east coast ports and the Erie Canal (Anonymous 1978).

Once introduced, marble may have been favored over sandstone because it was easier to carve. Marble, being composed of the mineral calcite (3 on Mohs scale of hardness), is softer than the sandstone of northern Ohio, composed primarily of quartz (7 on Mohs scale) and cemented primarily by silica. It is especially easier to carve three-dimensional objects in marble (Sloane 1991, p 41). In the early part of the 19th century, when stone cutting was done by hand or using waterpower, different degrees of difficulty associated with carving sandstone and marble was a likely factor in marble's prevalence. Retention of sandstone as a monument base after marble became the principal monument stone supports this view. Sandstone, being locally available and cheaper, was recognized for its durability, yet greater difficulties in carving it reduced its use as a principal monument stone after marble was introduced (although the prevailing Greek Revival attitudes were probably a bigger factor; see above). At a later time, the use of steam engines was incorporated into the production of monuments and, by the 1870s, marble was being cut with steel plates aided by sand, water, pumice, and cloth (Knight 1876, p 1389).

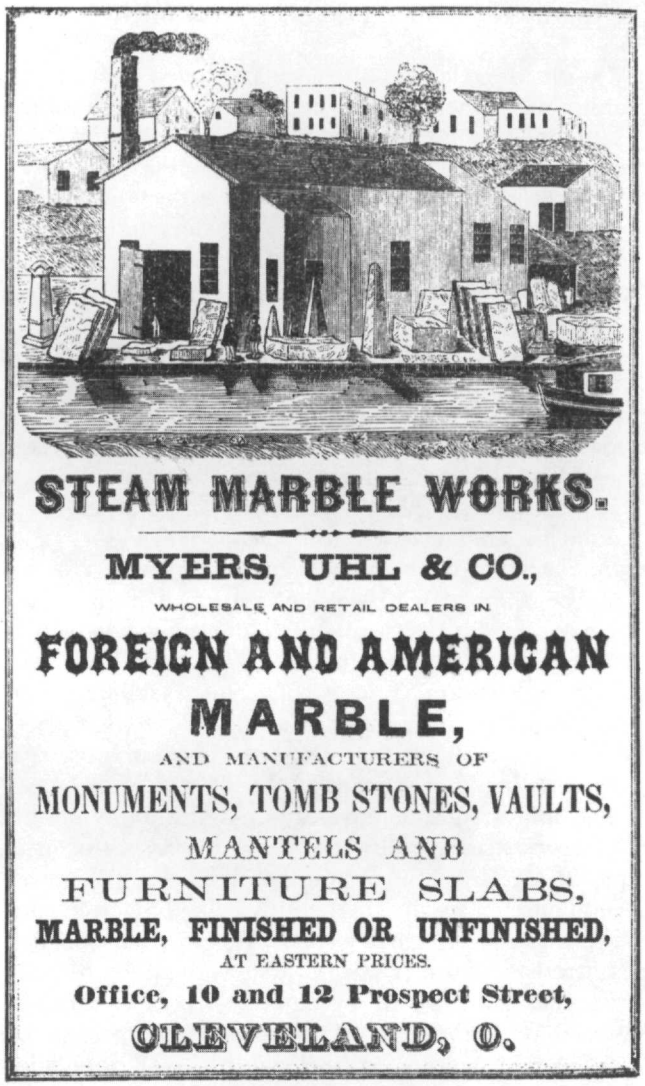

FIGURE 9. Advertisement for steam marble works of Meyers, Uhl and Co., located in Cleveland along the Ohio & Erie Canal. From Spear, Denison & Co. (1856). Marble gravestones in various stages of manufacture can be seen, as well as the prow of a canal boat.

In contrast to marble, the difficulty in carving granite was a likely detriment to its initial use. The section on building stone in the *International Library of Technology* (1909) reflects turn of the century views, noting that the great difficulty of working granite made it very expensive to cut (p 2). The same work notes that ease of carving is "one of the most important characteristics of marble" (p 3). The devices of the 1850s were simply not capable of turning or polishing rock of such hardness (Williams Bros. 1880, p 368). Technological advances, including the use of Carborundum as an abrasive in cutting (E. Kotecki, Jr., personal communication), and the development of pneumatic drills in the 1890s, followed closely by the use of sandblasting, greatly facilitated

the carving of granite monuments (Donnelly 1994, p 86-8).

Despite the relative difficulties associated with carving granite, the stone began to replace marble as a monument stone in the Cleveland region, as well as in other regions, by the 1870s. Clearly, people began to notice the weathering of marble. This was especially evident in New England, where the marble weathered much more quickly than earlier monuments made of slate. Dale (1912, p 38) predicted that lettering in white marble gravestones in New England would be "completely effaced within 300 years of the date of the cutting." Moreover, prior to the turn of the century, Buckley wrote, "Marble has been used very extensively in past years throughout the country, but at the present time it is sold mainly in the rural districts" (1898, p 426). He also noted, "It has been very largely supplanted by granite." According to Merrill (1891, p 2), granite was used extensively in Boston only when it could be shipped economically via canal from nearby Chelmsford. The development of the railway system in the United States, reaching areas beyond those near canals and natural bodies of water, facilitated the widespread use of granite. In addition, by 1890 prices for granite, at least that used for monuments, was much less than that of marble (Merrill 1891, p 422).

The importance of intra-regional variability should not be overshadowed by the above discussion of inter-regional similarities in monument stone use. There are several differences among the Ridgeville, Erie Street, and Warrensville West cemetery data. The most conspicuous characteristic of the Erie Street data is the persistent use of sandstone in small percentages as a monument material until the end of the 19th century (Fig. 6). Possible explanations for this include a small population of conservative individuals (for example, people who don't adopt prevailing material culture) or the existence of economic stratification (for example, people can't afford imported stone). Other evidence for variable diffusion of material culture exists between Ridgeville Cemetery and Warrensville West Cemetery; in the former, Gothic-point tablets increase throughout the century before peaking in the 1880s, in the latter, they peak in the 1850s and are confined to the preceding and subsequent decades (Fig. 7).

The continued use of marble at Ridgeville Cemetery is noteworthy. Since 1931, eight marble monuments have been erected at Ridgeville Cemetery, the latest of which indicates a 1979 date of death. In contrast, the last marble monument at Warrensville West and Erie Street cemeteries occur in the 1890s and 1910s, respectively. Thus, Ridgeville Cemetery conforms to Buckley's (1898, p 53) observations on New England cemeteries, that marble was sold to rural districts after it had stopped being used in urban areas. This may be due to conservatism or the lack of problematic weathering in North Ridgeville. In contrast to the synchronic introduction of marble in the three cemeteries, the non-contemporaneous introduction of granite among the three cemeteries suggests that a lag in cultural diffusion may have existed between urban and rural areas, although other possible reasons for the apparently early use of granite at Erie Street Cemetery and Warrensville West Cemetery were discussed above.

Differential marble weathering among Ridgeville, Erie Street, and Warrensville West cemeteries is almost certainly related to the geographic locations of the cemeteries relative to various pollution sources. On a continental wide scale, Meierding (1993a) determined that air pollution, mainly in the form of SO_2, was responsible for more deterioration of carbonate building stone than any other weathering process, including dissolution by acid rain and carbon monoxide automobile emissions. As a major industrial center in the late 19th and early 20th centuries, Cleveland had many producers of SO_2. Modeled sulfur dioxide levels between 1880 and 1980 in Cleveland by Lipfert (as reported in Meierding 1993a, Fig. 4B) show highest levels before and after the Depression, and much lower levels in the 1960s and afterward. Cleveland producers of SO_2 included iron and steel manufacturers (as early as 1880 28% of Cleveland workers worked in steel mills) and major sulfuric acid producers who supplied sulfuric acid to oil refineries. The chief source of atmospheric sulfur, however, was coal, used both by industry and for heating homes. The steel and chemical industries concentrated along the Cuyahoga River, just southwest of downtown Cleveland, along with its central city location, are the likely reasons for the high degree of weathering evidenced at Erie Street Cemetery and, because prevailing winds blow from the west, at Warrensville West Cemetery. As part of his continent-wide study, Meierding (1993a) measured the mean recession rates of marble tombstone faces from four Cleveland area cemeteries. Reported values for surface recession ranged from 1.07-1.98 mm/hundred years (Meierding 1993a, Fig. 4B). Meierding's weathering results display a somewhat similar geographic distribution to ours. As in our study, he recorded the lowest rate of surface recession in a western suburb or area of Cleveland. Meierding's highest rate was in the vicinity of the central industrial area.

That the age of marble tablets is not a predictor of Meierding Scale weathering at the Erie Street and Warrensville West cemeteries in part supports the reasoning that other factors, such as pollution, are better explanations. Weathering data from Ridgeville Cemetery, far removed from industrial Cleveland and on its windward side, suggests that in rural areas marble weathering is more closely a function of time than in urban industrial areas; however, subjectivity in Meierding Scale assessment, antedated tombstones, depth that lettering was originally inscribed, and tombstone aspect in relation to prevailing winds (to name but a few factors) also may have affected weathering results.

CONCLUSIONS

By recording stone use, monument style, and weathering in three Cleveland area cemeteries, and relating that data to historical records, with particular emphasis on prevailing material culture, and developments in stone carving and transportation during the 19th century, we have documented factors by which early cemeteries

gained their eclectic appearance. The most influential of these were a reliance on local materials before efficient shipping and transport existed, the Greek Revival movement, the opening of transportation corridors, and technological developments in industrial carving, grinding, and polishing during the 19th century. Seriation curves documenting stone use over time for the three cemeteries vary. Comparison with historical records, particularly advertisements, shows that the seriation pattern for the most rural of the cemeteries most likely documents the introduction of stone types to the area. Side effects of technological development—anthropogenic pollutants—have degraded the cemeteries' appearance over time. Differential weathering of marble gravestones in the cemeteries studied is related to the cemeteries' locations in relation to pollution sources: the effects of weathering are most severe in Erie Street Cemetery, in downtown Cleveland.

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